

Accessibility Theory to Guide the Development of Achievement Test Items for All Students



Presenters:

Peter A. Beddow & Ryan J. Kettler

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June, 2010

How Accessible is this item?

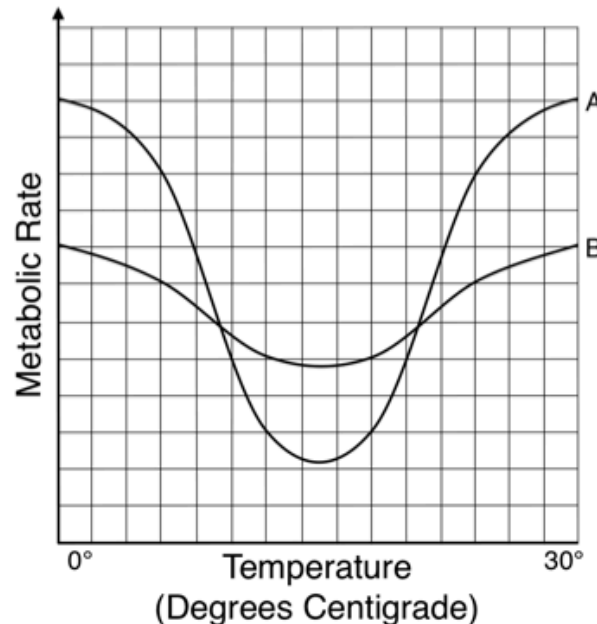
Grade: 11

Construct:

Use knowledge of biological concepts to interpret graphed data.

4. The temperature of the Pacific Ocean ranges from near freezing (32° Fahrenheit, 0° Centigrade) at the poles to 86° Fahrenheit (30° Centigrade) in close proximity to the equator. The salinity of the water is highest at the mid-latitudes. The salinity of the water near the equator is quite low because there is a greater amount of equatorial precipitation. Likewise, there is low salinity at the poles because of the decreased evaporation due to the extremely low temperatures.

The graph below shows the metabolic rates of Organism A and Organism B in the Pacific Ocean at different water temperatures.



Based on the graph, what is the BEST conclusion that can be drawn about the two organisms?

- ✓ A. Organism A is less well adapted for life at the mid-latitudes than Organism B.
- B. Organism B is better adapted for life at the poles compared to Organism A.
- C. Organism B is better adapted than Organism A for life in water with low salt content.
- D. Organism A and Organism B are equally well adapted for life at the equator.

- 4 Maximally Accessible for Nearly All Test-Takers
- 3 Maximally Accessible for Most Test-Takers
- 2 Maximally Accessible for Some Test-Takers
- 1 Inaccessible for Many Test-Takers

Session Objectives

- **Background of AA-MAS and OAASIS project (Kettler);**
- **OAASIS Pilot Study Results (Kettler).**
- **Accessibility Theory & Item Reviews (Beddow)**
 - Provide an overview of accessibility theory to situate the methods used to modify items for the OAASIS pilot study (Beddow);
 - Review the results of item accessibility reviews for South Carolina, South Dakota, and Wyoming, including common trends and characteristics that differed across states (Beddow);
 - Demonstrate the item evaluation & modification process using an example item.

Accessibility

- **Test accessibility** is the extent to which a test and its constituent item set permit the test-taker to demonstrate knowledge of the target construct. Thus, an accessible test:
 1. Eliminates barriers;
 2. Permits equal access to all components and features for the totality of the target population of the test; and
 3. Yields scores from which subsequent inferences do not reflect error that is the result of incomplete test-taker access.



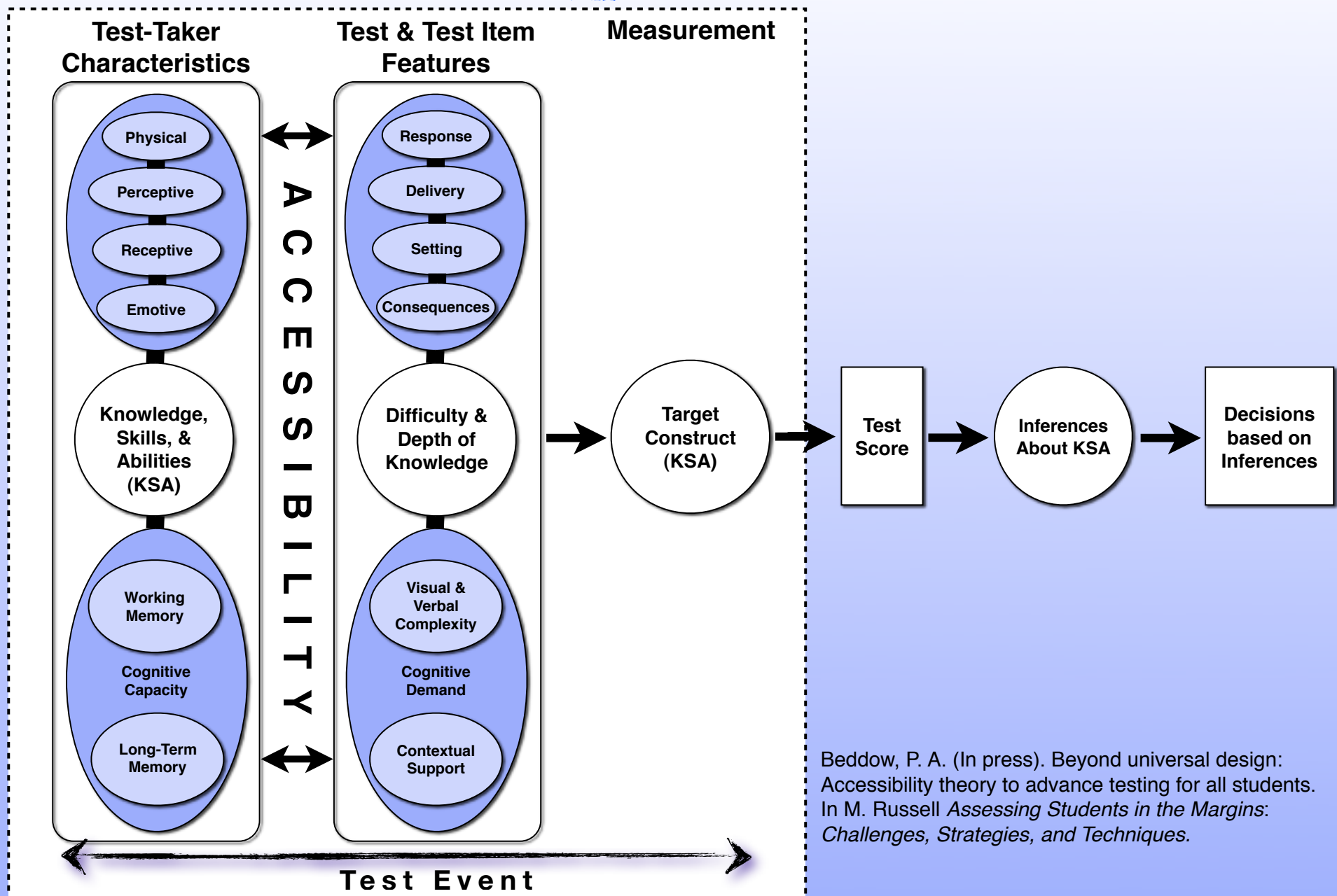
Accessibility is an Interaction

- Accessibility involves an **interaction** between characteristics of the test and individual test-taker characteristics.
- A test event may permit one individual to access the target construct with minimal effort, whereas for another individual, the same test event may require the expenditure of essential cognitive resources to gain access the target construct.
- Both individuals may be equally knowledgeable of the tested content, but accessibility issues may preclude one from demonstrating what he or she knows.

Accessibility Theory



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Beddow, P. A. (In press). Beyond universal design: Accessibility theory to advance testing for all students. In M. Russell *Assessing Students in the Margins: Challenges, Strategies, and Techniques*.

TAMI

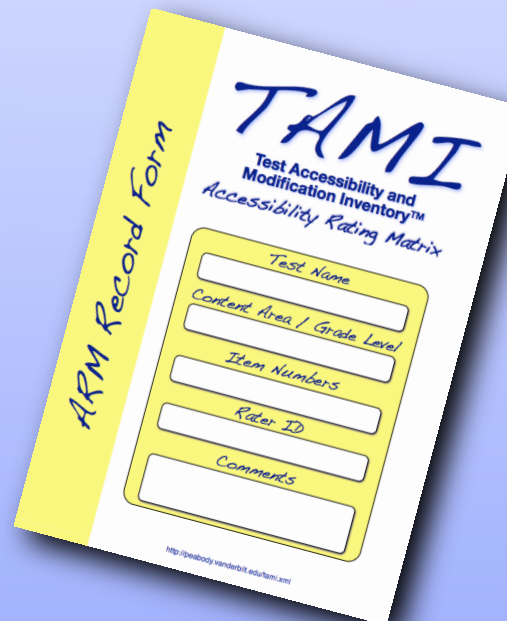


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Test Accessibility and Modification Inventory™

Accessibility Rating Matrix

<http://peabody.vanderbilt.edu/tami.xml>



TAMI: Overview

- The Test Accessibility and Modification Inventory (TAMI; Beddow, Kettler, & Elliott, 2008) and Accessibility Rating Matrix (Beddow, Elliott, & Kettler, 2009) were developed as evaluation and decision-making tools to facilitate the analysis of new and existing tests and test items with the purpose of enhancing their accessibility.
- The TAMI was influenced by four primary areas of study:
 - 1) Universal design principles (Mace, 1997);
 - 2) Cognitive load theory (Chandler & Sweller, 1991);
 - 3) Research on test and item development (Rodriguez, 2005); and
 - 4) Guidance on web and computer accessibility (Bennett, 2001).

Anatomy of an Item

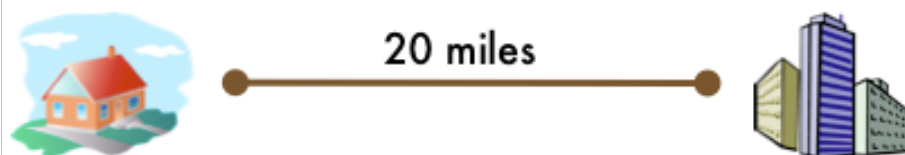
Stimulus →

Visual →

Stem →

Answer Choices →
key (**B**) and
distractors (**A** & **C**)

Mr. Murphy uses his car to get to work
three days each week.



How many miles does Mr. Murphy drive
to and from his job each week?

~~A~~ 60 miles

B. 120 miles

~~C~~ 200 miles

Page Layout

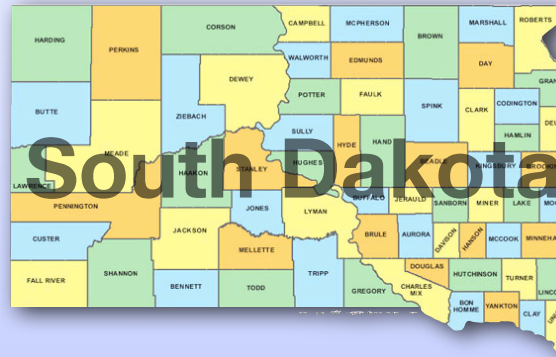
Overall Analysis

ARM Accessibility Levels

Level	Description	Heuristic
4	Maximally Accessible for Nearly All Test-Takers	Optimal accessibility for between 95-99% of the population
3	Maximally Accessible for Most Test-Takers	Optimal accessibility for between 90-95% of the population
2	Maximally Accessible for Some Test-Takers	Optimal accessibility for between 85-90% of the population
1	Inaccessible for Many Test-Takers	Optimal accessibility for fewer than 85% of the population

Accessibility levels reflect the approximate portion of the test-taker population for whom the item is likely to be **maximally accessible** (i.e., who freely are able to show the extent of their knowledge of the target construct).

Item Accessibility Reviews



Item Accessibility Review

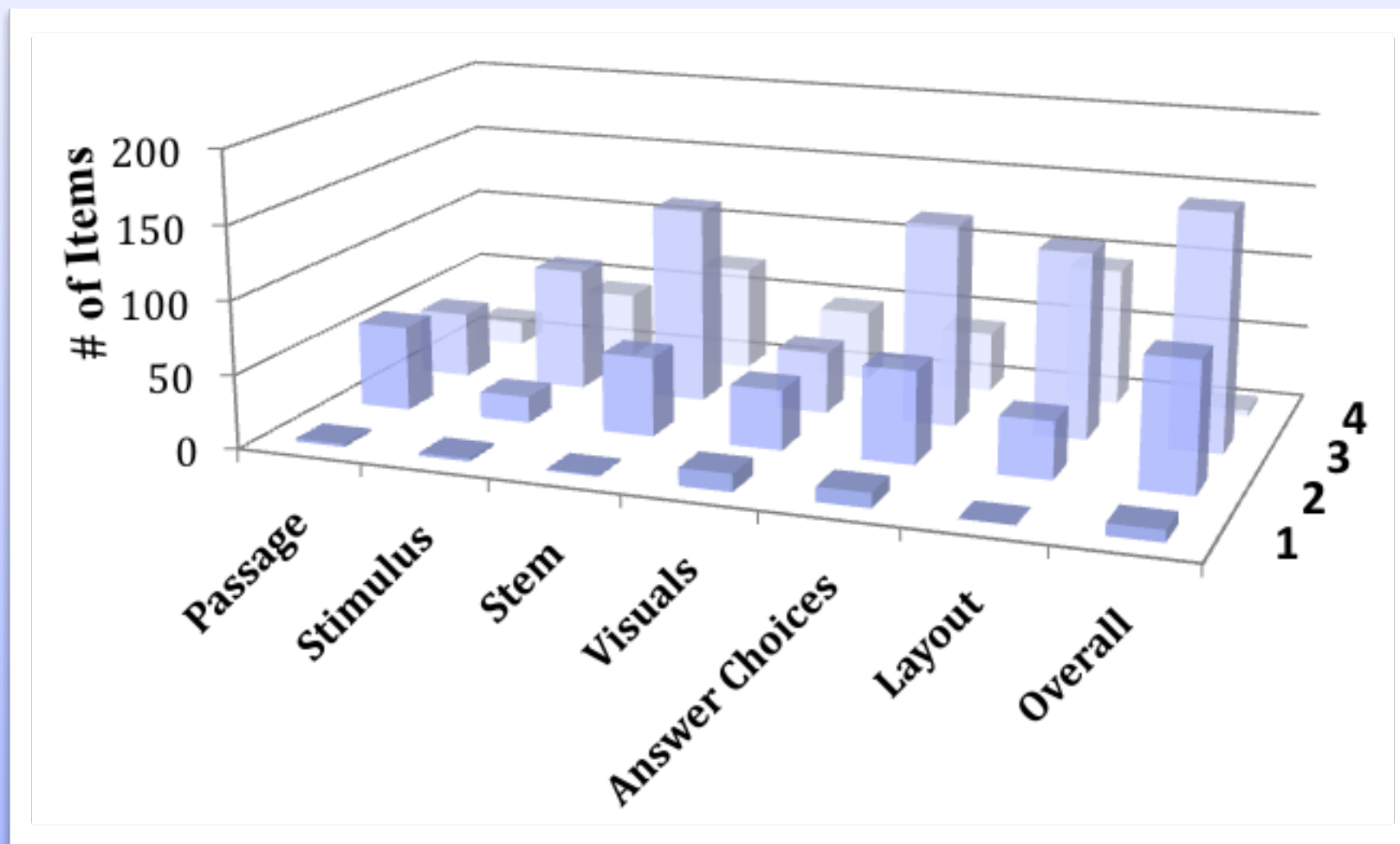
- The TAMU Evaluation Team at Vanderbilt evaluated the accessibility of a sample of 261 science items from South Carolina, South Dakota, and Wyoming in grades 4, 5, 8, and 11.
- To ensure optimal reliability, 25% of items were rated by 2 raters. If agreement was not reached on any item, the team conferred to establish a consensus rating.



Item Information

Recommended Item Information	Reviewed Items
1. Content Area	✓
2. Grade Level	✓
3. Target Construct / Strand / Skill	
4. Depth of Knowledge (DOK) Level ¹	✓
5. Key (correct response)	✓
6. Difficulty for Overall Sample (p) and Disaggregated by Test Score Range Disaggregated by Disability Status	✓
8. Point-biserial statistics ($Ptbs$)	✓
9. Response Frequencies Disaggregated by Test Score Range Disaggregated by Disability Status	
10. Rationale for Each Distractor	
11. Readability Level	
12. Item in Actual Form	✓

Combined Results



$N = 261$ items

Combined Results

		Item Analysis Rubric Ratings						Overall Analysis Rubric Ratings
		Passage	Item Stimulus	Item Stem	Visuals	Answer Choices	Page / Item Layout	
Grade	# (% of total)	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>
Total	261 (100%)	2.6 (0.7)	3.2 (0.7)	3.1 (0.7)	2.8 (1.0)	2.8 (0.7)	3.2 (0.7)	2.6 (0.6)
Grade 4³	33 (13%)	2.2 (0.6)	3.4 (0.5)	2.7 (0.7)	2.5 (0.9)	2.5 (0.7)	3.0 (0.7)	2.3 (0.5)
Grade 5²	30 (11%)	4.0 (--)	2.9 (0.6)	2.9 (0.7)	2.8 (1.1)	3.0 (0.7)	3.4 (0.7)	2.6 (0.6)
Grade 8²³	63 (24%)	2.7 (0.7)	3.3 (0.8)	3.2 (0.7)	3.1 (0.8)	2.8 (0.8)	3.1 (0.7)	2.6 (0.5)
Grade 11¹²³	135 (52%)	2.8 (0.7)	3.1 (0.7)	3.1 (0.7)	2.9 (0.7)	2.9 (0.7)	3.3 (0.6)	2.7 (0.6)

General Considerations

1) Before perusing the item data, **complete the item independently**.

- a) Engage in the process of responding to the item as though you were the test-taker.

2) Is there more than one correct response?

- a) Is there a strong rationale / logical argument that could be made that one or more of the distractors is **correct**?
- b) Items for which there is more than one correct response receive **Answer Choices** and **Overall** accessibility ratings **no higher than 1**.
 - i) Similarly, if one or more distractors may be so plausible as to likely cause unnecessary confusion for the test-taker (and not simply represent common errors), rate the item **no higher than 2**.

General Considerations (cont.)

3) Does the item require the test-taker to turn the page?

- Items that require the test-taker to flip back and forth receive **Page/Item Layout** and **Overall** accessibility ratings **no higher than 3**. Examples:
 - Items that are on a separate page from the corresponding passage, stimulus, or visual;
 - Passages that are comprised of more than 2 **facing** pages, including corresponding items.
 - Items that require the test-taker to reference a separate formula page.

4) Start at the highest level of the rubric and work down.

- If the 4 level is true for the item, rate 4 for that category. If the rubric contains a statement that is false for the item, work backward until you find the closest approximation to the rubric level that is true for the item.

Positive Attributes

- **The evaluation team identified several positive attributes across the item sample, specifically noting:**
 - The use of plain wording of item stems and answer choices;
 - The inclusion of most information necessary for responding on a single page.

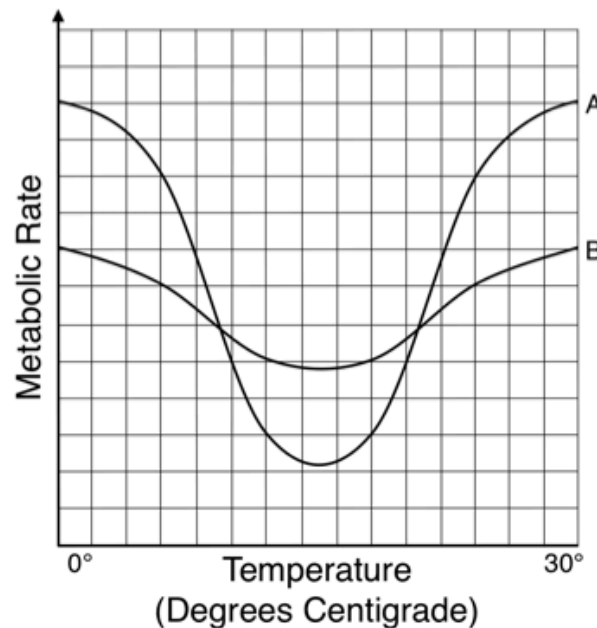
Recommendations

- **The evaluation team made several recommendations to improve the accessibility of the items, including:**
 - Simplify item layouts
 - Distinguish item stimuli from item stems;
 - Simplify language in stimuli;
 - Eliminate unnecessary visuals; and
 - Attend to the possibility of multiple item keys.
- Additionally, the team suggested using three answer choices when possible to reduce reading load and cognitive demand.

Example Item

4. The temperature of the Pacific Ocean ranges from near freezing (32° Fahrenheit, 0° Centigrade) at the poles to 86° Fahrenheit (30° Centigrade) in close proximity to the equator. The salinity of the water is highest at the mid-latitudes. The salinity of the water near the equator is quite low because there is a greater amount of equatorial precipitation. Likewise, there is low salinity at the poles because of the decreased evaporation due to the extremely low temperatures.

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Grade: 11
Construct:
Use
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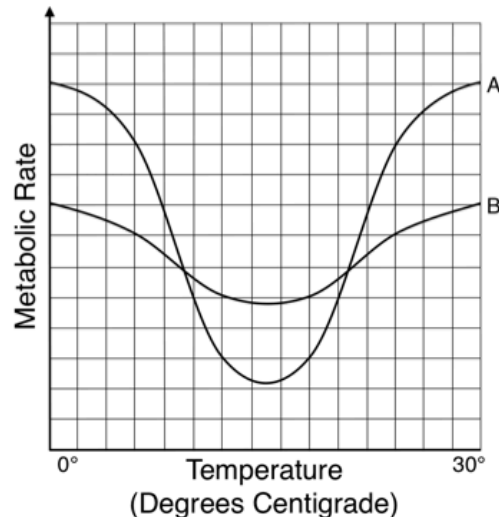
Example Item



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Passage
/ Item
Stimulus

Item
Stem

Visuals

Answer
Choices

Page/
Item
Layout

Overall

Modification Guide

Item:
4

A = Add a passage or item stimulus.
E = Eliminate passage or item stimulus.
S = Simplify / shorten text.
R = Reorganize information.
D = Modify the directions.
F = Change text formatting (**bold**, etc.)
Note: Write X in the Rating Box if the item has no passage or stimulus.

Pass.	Stim.	Pa
1	3	
A: <input type="checkbox"/>	A: <input type="checkbox"/>	A: <input type="checkbox"/>
E: <input type="checkbox"/>	E: <input type="checkbox"/>	E: <input type="checkbox"/>
S: <input checked="" type="checkbox"/>	S: <input checked="" type="checkbox"/>	S: <input type="checkbox"/>
R: <input checked="" type="checkbox"/>	R: <input type="checkbox"/>	R: <input type="checkbox"/>
D: <input type="checkbox"/>	D: <input type="checkbox"/>	D: <input type="checkbox"/>
F: <input checked="" type="checkbox"/>	F: <input type="checkbox"/>	F: <input type="checkbox"/>

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S: <input type="checkbox"/>	S: <input type="checkbox"/>
C: <input type="checkbox"/>	C: <input type="checkbox"/>
Q: <input type="checkbox"/>	Q: <input type="checkbox"/>
A: <input type="checkbox"/>	A: <input type="checkbox"/>
N: <input type="checkbox"/>	N: <input type="checkbox"/>
F: <input type="checkbox"/>	F: <input type="checkbox"/>

A = Add a visual.
E = Eliminate visual(s).
M = Move visual(s).
S = Simplify visual(s).
Note: Write X in the Rating Box if the item does not have a picture, chart, table, or figure.

A: <input type="checkbox"/>	A: <input type="checkbox"/>
E: <input type="checkbox"/>	E: <input type="checkbox"/>
M: <input type="checkbox"/>	M: <input type="checkbox"/>
S: <input type="checkbox"/>	S: <input type="checkbox"/>

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Note: Write X in the Rating Box if the item is not a multiple-choice item.

S: <input type="checkbox"/>	S: <input type="checkbox"/>
R: <input type="checkbox"/>	R: <input type="checkbox"/>
E: <input type="checkbox"/>	E: <input type="checkbox"/>
O: <input type="checkbox"/>	O: <input type="checkbox"/>
B: <input type="checkbox"/>	B: <input type="checkbox"/>
M: <input type="checkbox"/>	M: <input type="checkbox"/>

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E: <input type="checkbox"/>	E: <input type="checkbox"/>
W: <input type="checkbox"/>	W: <input type="checkbox"/>
S: <input type="checkbox"/>	S: <input type="checkbox"/>
F: <input type="checkbox"/>	F: <input type="checkbox"/>
M: <input type="checkbox"/>	M: <input type="checkbox"/>
R: <input type="checkbox"/>	R: <input type="checkbox"/>

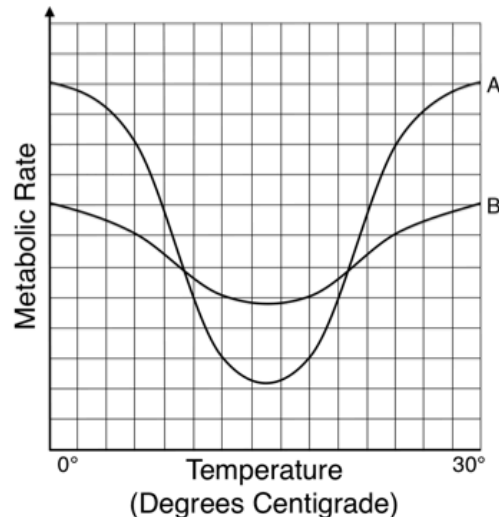
Other codes:

<input type="checkbox"/>	<input type="checkbox"/>
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Pass.	Stim.	Pa
1	3	
A: —	A: —	A: —
E: —	E: —	E: —
S: X	S: X	S: —
R: X	R: —	R: —
D: —	D: —	D: —
F: X	F: —	F: —

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S: X	3	S: —
C: —		C: —
Q: —		Q: —
A: X		A: —
N: —		N: —
F: X		F: —

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E: —		E: —
M: —		M: —
S: —		S: —

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R: —		R: —
E: —		E: —
O: —		O: —
B: —		B: —
M: —		M: —

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W: —		W: —
S: —		S: —
F: —		F: —
M: —		M: —
R: —		R: —

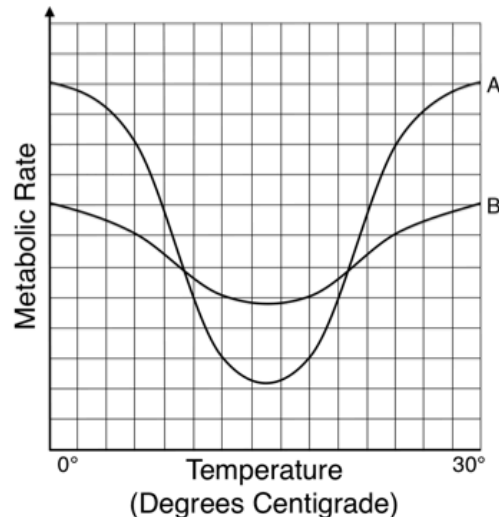
Other codes:

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1	3	
A: —	A: —	A: —
E: —	E: —	E: —
S: X	S: X	S: —
R: X	R: —	R: —
D: —	D: —	D: —
F: X	F: —	F: —

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S: X	3	S: —
C: —		C: —
Q: —		Q: —
A: X		A: —
N: —		N: —
F: X		F: —

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	1	
A: —		A: —
E: —		E: —
M: —		M: —
S: X		S: —

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S: —		S: —
R: —		R: —
E: —		E: —
O: —		O: —
B: —		B: —
M: —		M: —

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E: —		E: —
W: —		W: —
S: —		S: —
F: —		F: —
M: —		M: —
R: —		R: —

Other codes:

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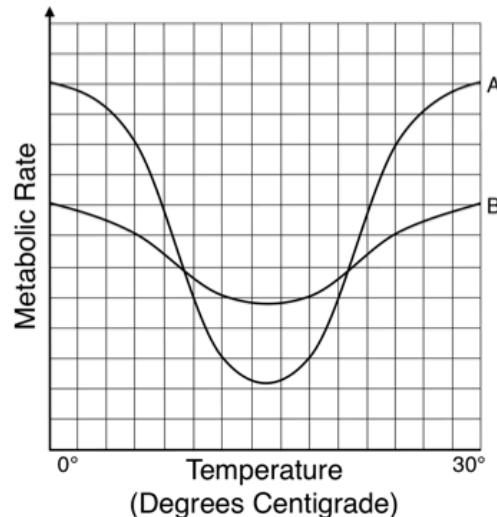
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A: —	A: —	A: —
E: —	E: —	E: —
S: X	S: X	S: —
R: X	R: —	R: —
D: —	D: —	D: —
F: X	F: —	F: —

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Q: —		Q: —
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F: —		F: —
M: —		M: —
R: —		R: —

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--	--

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Answer
Choices

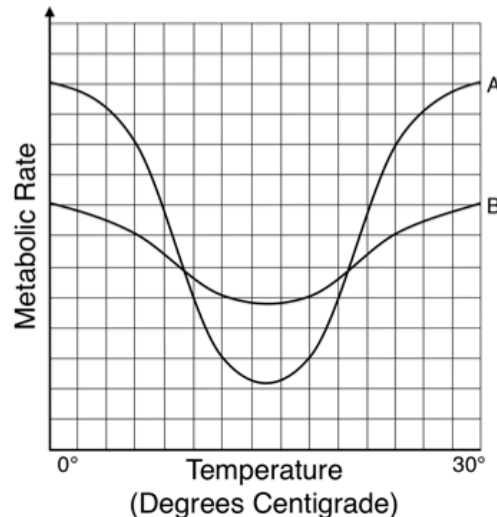
Page/
Item
Layout

Overall

Example Item

4. The temperature of the Pacific Ocean ranges from near freezing (32° Fahrenheit, 0° Centigrade) at the poles to 86° Fahrenheit (30° Centigrade) in close proximity to the equator. The salinity of the water is highest at the mid-latitudes. The salinity of the water near the equator is quite low because there is a greater amount of equatorial precipitation. Likewise, there is low salinity at the poles because of the decreased evaporation due to the extremely low temperatures.

The graph below shows the metabolic rates of Organism A and Organism B in the Pacific Ocean at different water temperatures.



Based on the graph, what is the BEST conclusion that can be drawn about the two organisms?

- ✓ A. Organism A is less well adapted for life at the mid-latitudes than Organism B.
- B. Organism B is better adapted for life at the poles compared to Organism A.
- C. Organism B is better adapted than Organism A for life in water with low salt content.
- D. Organism A and Organism B are equally well adapted for life at the equator.

Passage
/ Item
Stimulus

Item
Stem

Visuals

Answer
Choices

Page/
Item
Layout

Overall

Modification Guide

Item:
4

A = Add a passage or item stimulus.
E = Eliminate passage or item stimulus.
S = Simplify / shorten text.
R = Reorganize information.
D = Modify the directions.
F = Change text formatting (**bold**, etc.)
Note: Write X in the Rating Box if the item has no passage or stimulus.

Pass.	Stim.	Pa
1	3	
A: —	A: —	A: —
E: —	E: —	E: —
S: X	S: X	S: —
R: X	R: —	R: —
D: —	D: —	D: —
F: X	F: —	F: —

S = Simplify / shorten stem.
C = Clarify question or directive.
Q = Change stem to a question.
A = Use active voice.
N = Eliminate negative stem.
F = Change text formatting (**bold**, etc.)
Note: Write X in the Rating Box if the item does not have a stem.

S: X	3	S: —
C: —		C: —
Q: —		Q: —
A: X		A: —
N: —		N: —
F: X		F: —

A = Add a visual.
E = Eliminate visual(s).
M = Move visual(s).
S = Simplify visual(s).
Note: Write X in the Rating Box if the item does not have a picture, chart, table, or figure.

	1	
A: —		A: —
E: —		E: —
M: —		M: —
S: X		S: —

S = Simplify / shorten text.
R = Revise answer choices.
E = Eliminate distractor(s).
O = Change the order of choices.
B = Balance issues.
M = More than one correct response.
Note: Write X in the Rating Box if the item is not a multiple-choice item.

S: X	1	S: —
R: X		R: —
E: X		E: —
O: X		O: —
B: X		B: —
M: —		M: —

E = Embed item in passage.
W = Increase white space.
S = Change size of item elements.
F = Change font size.
M = Move item / change item order.
R = Reduce spread of information across multiple pages/screens.

E: —	2	E: —
W: X		W: —
S: —		S: —
F: —		F: —
M: —		M: —
R: —		R: —

Other codes:

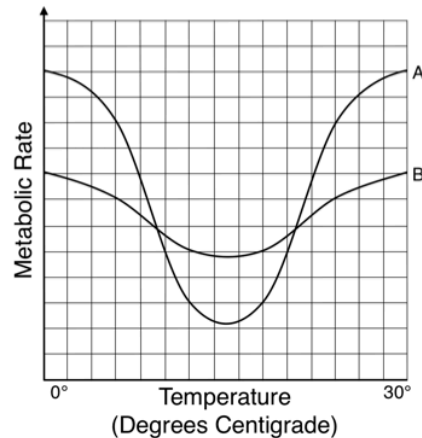
1	
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Example Item

Original

4. The temperature of the Pacific Ocean ranges from near freezing (32° Fahrenheit, 0° Centigrade) at the poles to 86° Fahrenheit (30° Centigrade) in close proximity to the equator. The salinity of the water is highest at the mid-latitudes. The salinity of the water near the equator is quite low because there is a greater amount of equatorial precipitation. Likewise, there is low salinity at the poles because of the decreased evaporation due to the extremely low temperatures.

The graph below shows the metabolic rates of Organism A and Organism B in the Pacific Ocean at different water temperatures.



Based on the graph, what is the BEST conclusion that can be drawn about the two organisms?

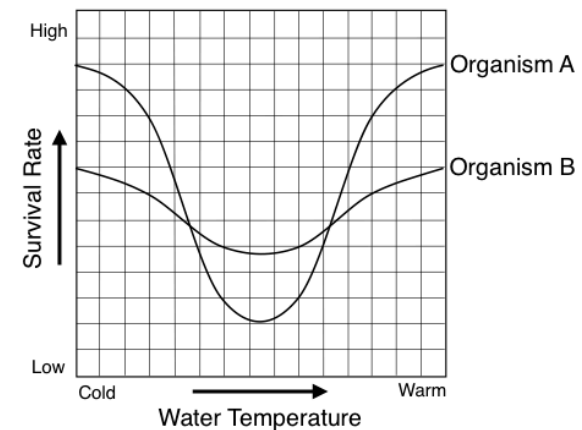
- ☒ A. Organism A is less well adapted for life at the mid-latitudes than Organism B.
B. Organism B is better adapted for life at the poles compared to Organism A.
C. Organism B is better adapted than Organism A for life in water with low salt content.
D. Organism A and Organism B are equally well adapted for life at the equator.

Modified

4. Use these facts about the Pacific Ocean to answer the question.

- The amount of salt in water is called **salinity**.
- The salinity of the water in the Pacific Ocean is **lowest** in water that is **very cold** or **very warm**.

The graph below shows the survival rates of two organisms at different water temperatures.



Based on the graph, what could you conclude about the two organisms?

- ☒ ☐ A. Organism A is better adapted for life in water with low salinity than Organism B.
☐ B. Organism B is better adapted for life in water with low salinity than Organism A.
☐ C. Organism A and Organism B are equally well adapted for life in water with low salinity.

Conclusion

- **Items can be improved to reduce access barriers for students with a broad range of abilities and needs.**
 - Increased access = Better measurement;
 - Better measurement = Better results;
 - Better results = More reliable and valid information about student abilities and needs.
 - The more we know about the abilities and needs of the students we serve, the greater our confidence in the many decisions we make on their behalf.



Thank you

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